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Stand Density Affects Growth of Choctawhatchee Sand Pine

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*ABSTRACT. Choctawhatchee sand pine (*Pinus clausa *var.* immuginata *D. B. Ward) was grown for 20 years at densities of 400, 600, and 800 trees per acre. Growing Choctawhatchee sand pine at 400 trees per acre resulted in significantly larger trees, but less wood was produced per acre than at higher densities. The ideal density depends on the management objectives, but for rotations of 20–25 years and chip harvesting systems, a density of 600 trees is recommended. For rotations of 30–35 years with conventional bolt and log harvests, 400 to 500 trees per acre seems better.*

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Scattered throughout the Southeastern Coastal Plain of the United States are thousands of acres of acid sands. These marine deposits from the Pleistocene epoch are an important physiographic feature of central and northwest Florida, and they occupy significant areas of Georgia, South Carolina, and North Carolina in the transition zone between the Upper Coastal Plain and the Piedmont (Burns and Hebb 1972). These areas represent a significant—and largely underutilized—acreage available for productive forestry.

Research has shown that Choctawhatchee sand pine is the best choice for these sandhill sites (Brendemuehl 1981), except in central Florida where the native Ocala sand pine (*P. clausa* var. *clausa* D. B. Ward) does better (Outcalt 1983). Based on this information, the sandhills of the Southeast are increasingly being planted to Choctawhatchee sand pine.

Due to sorting action during deposition, sandhill soils are largely quartz sands, ranging from a few feet to more than 20 ft deep. Organic matter content is low because the climate promotes rapid decomposition. Because of the low levels of organic matter and clay colloids, sandhills soils are typically acid, infertile, and droughty (Burns and Hebb 1972). The productive potential of such sites suggests that they will not economically support very dense stands. Optimum density, however, is not known. The objective of this study was to determine the effect of density on the productivity of Choctawhatchee sand pine on a typical sandhills site.

METHODS

The study is on the Chipola Experimental Forest in Calhoun County, Florida. The soil is a droughty, deep sand of the Lakeland series (thermic, coated, Typic Quartzipsamment). During the summer of 1963, the vegetation [mainly scrub oak (*Quercus* spp.) with wiregrass (*Aristida* spp.)] on the 20-acre study site was chopped using an 11-ton Marden duplex brush cutter. In January 1964, 1-0 Choctawhatchee sand pine seedlings were machine planted about 3 ft apart in rows spaced 4 ft apart.

Four blocks, each containing five 1-acre treatment plots, were established in a randomized block design. A 0.25-acre interior plot was established in each treatment plot for data collection. Within each block, the plots were randomly assigned densities of 400, 600, or 800 trees per acre. Each block contains two plots with densities of 600 and 800 trees with the intention to thin one of the pair to 200 and one to 400 trees per acre at age 25. In the early summer of 1967 (plantation age 3), all plots were thinned to their prescribed densities. This was accomplished by mechanically removing every other row and hand thinning within rows. The configuration that resulted was rows 8 ft apart with trees spaced at about 7, 9, and 14 ft for the 800, 600, and 400 tree per acre densities, respectively.

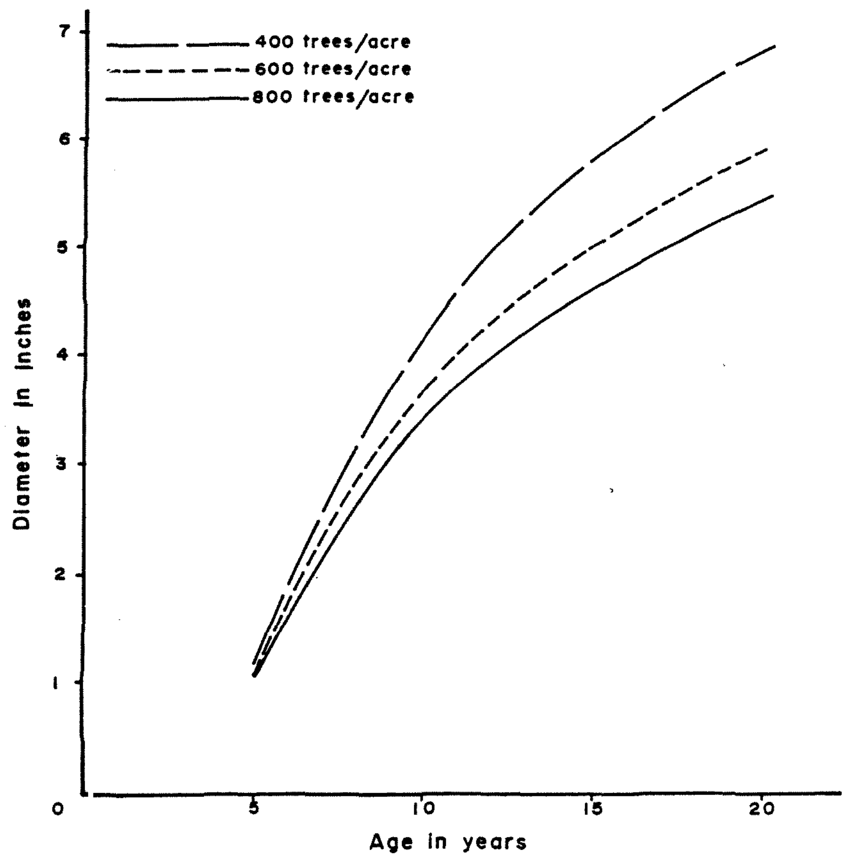

Figure 1. Average diameter of 20-year-old Choctawhatchee sand pine grown at 400, 600, and 800 trees per acre.

RESULTS AND DISCUSSION

Most of the mortality in Choctawhatchee sand pine occurs the first year after planting, with very little thereafter. Because of this and the way the study was established (with a high planting density and plots thinned to the desired densities at age 3) survival has been nearly 100 percent. The limited mortality has been due to bark beetle attacks and not suppression. Thus, these sandhill sites are capable of carrying at least 800 trees per acre without high natural thinning losses from suppression. Even at much higher densities losses to mortality should be low. Rockwood and others (1980) reported survival of greater than 80 percent through age 17 years for densities in excess of 3000 trees per acre. Therefore, virtually all of the wood that would be produced in stands at 800 trees per acre or less should be available for harvest at a rotation age of 20–25 years.

As expected, an inverse relationship exists between density and diameter growth (Figure 1). This difference has been especially pronounced since crown closure occurred at about age 10 years. After 20 years, trees planted at 600 per acre had average diameters significantly larger than those grown at 800 per acre (Table 1). Figure 1 indicates that although there is still some small difference in diameter growth rate between these two densities, the relative difference in average diameters will not change much from now to rotation age. The difference in diameter growth rates between 400 trees per acre and 600 per acre has, and continues to be, much more pronounced, which will cause the difference in average diameter to increase through rotation age. Therefore, although growing Choctawhatchee sand pine at 600

Table 1. Diameter, height, and volume of Choctawhatchee sand pine by density class at 20 years of age.

Density	Diameter	Height	Total stem volume	Merchantable[1] volume
(trees/ac)	(in.)	(ft)	(ft^3/ac)	(ft^3/ac)
400	6.85a[2]	47.8a	2330a	2275a
600	5.94b	47.9a	2800b	2695b
800	5.48c	44.8b	2740b	2575ab

[1] Stem volume outside bark from groundline to a 3-in. dob top. [Volumes are based on equations by McNab et al. (in press.)]

[2] Values within a column not followed by the same letter are significantly different at the 0.05 level.

rather than 800 trees per acre will cause statistically larger diameters, it is not likely to have much practical effect on average product size at harvest time, but growing them at 400 per acre will.

For the first 15 years of stand development, height growth was relatively independent of density. Between ages 15 and 20, however, height growth has been slowed on the 800 per acre plots due to competition, resulting in significantly shorter trees than those grown at the other two densities. Trees on the 400 and 600 per acre plots continued to gain in height at the same rate, and no significant differences in average tree height were detected (Table 1). Dominant trees are of equal height on all plots, but there are more trees in the lower crown classes on the 800 per acre plots. Therefore, growing Choctawhatchee sand pine at densities of 800 trees per acre or greater will result in some loss in total height growth.

Total net volume production after 20 years was lower on the 400 tree per acre plots than on the 600 or 800 per acre plots (Table 1). The 800 tree per acre plots declined in productivity between 15 and 20 years relative to the other densities and the previous 5-year period (Figure 2). Therefore, 800 trees per acre is too dense. Growing Choctawhatchee sand pine at 600 trees per acre produces just as much wood at age 20 and, because of the difference in present productivity, would produce more with longer rotations. The ranking is not as clear for conventional merchantable volume to a 3-in. top, but something around 600 trees per acre appears to maximize merchantable volume production. However, because of the greater diameter growth rate of the trees on the 400 trees per acre plots, they may be nearly as productive by age 35 y. This rotation age and density is best suited to the production of small sawlog material rather than pulpwood. Unfortunately very little market exists for such material at the present time.

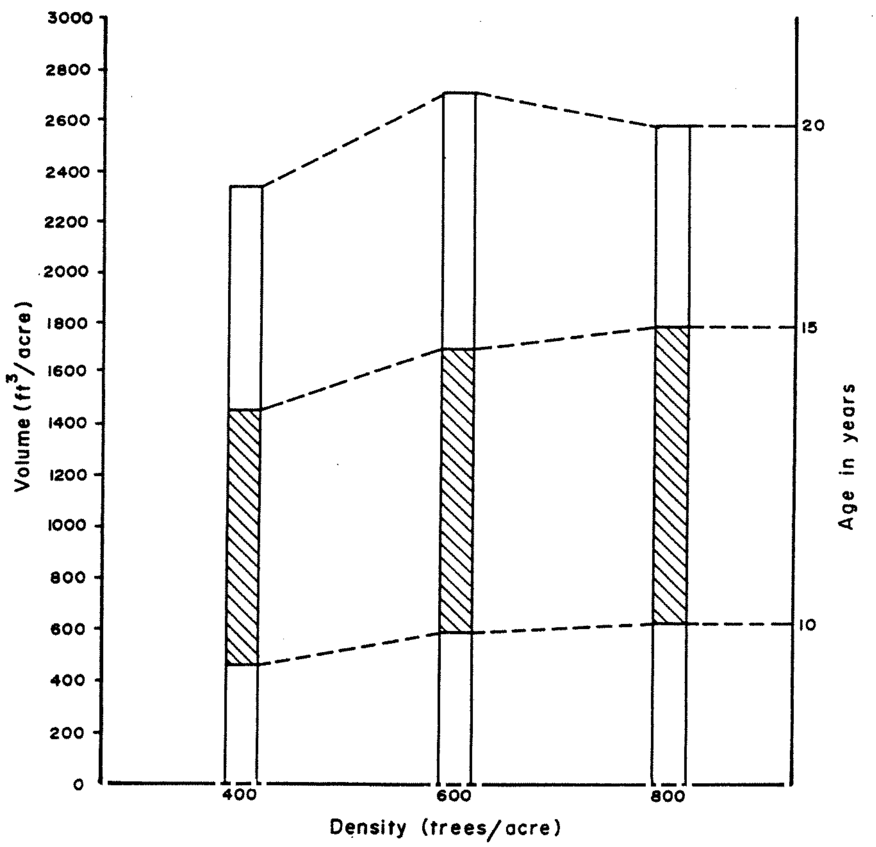

Figure 2. Volume production to 3-in. dob by Choctawhatchee sand pine grown at different densities.

The ideal density for growing Choctawhatchee sand pine depends on management objectives. If planned rotations are 20 to 25 years, the 600 tree per acre density would be more productive than lesser densities. If expected rotation ages are 30 to 35 years, however, densities ranging from 400 to 600 trees per acre should be about equally productive. The likely harvest method also affects the choice of density. At 400 trees per acre there are fewer and larger trees to harvest. If a conventional shortwood harvest is anticipated, larger trees would be a definite advantage. If the trees are to be harvested mechanically and chipped on site, the predominant system of the future, tree size is less of a factor, and the greater volume produced by the denser plantings would be more important—especially for short rotations. Based on the results of this study, expected rotation lengths of 20 to 25 years and the growing use of mechanical harvesting, the best strategy for pulpwood production is to manage for 600 Choctawhatchee sand pine per acre surviving after the first growing season. □

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